Clark County Volunteer Monitoring Program
Ambient Stream Monitoring

Quality Assurance Project Plan

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Purpose of the Quality Assurance Project Plan

Clark County Public Works Water Resources (Water Resources) requires a QAPP for each monitoring project. The plan addresses project design, schedule, methods of data collection and management, quality assurance and quality control requirements, data analysis, and reporting. Water Resources follows the general Quality Assurance Project Plan (QAPP) format defined by the State of Washington Department of Ecology (Ecology) (Lombard and Kirchmer, 2001). Water Resources

Background and Problem Statement

Clark County Clean Water Program

Volunteer monitoring is an integral part of **Clark County's Clean Water Program**. Clark County initiated the Clean Water Program in 2000 to increase protection for our streams, lakes, and groundwater. The program began in response to federal and state mandates for local government agencies to better control and clean stormwater runoff. The Clean Water Fee, which is paid by property owners in unincorporated Clark County, supports the enhanced levels of service required to accomplish these goals (Clean Water Program Annual Report, 2001 summary).

One of the first requirements for protecting or improving water quality is to have a solid foundation of standards, facilities, and programs in place. Since the Clean Water Program began, Clark County has focused on building that foundation by:

- improving stormwater and water quality facilities
- upgrading the standards that protect our water quality
- enhancing inspection, maintenance, monitoring, and education programs
- enhancing enforcement of stormwater regulations

Step by step, the Clean Water Program is building the kind of comprehensive monitoring program that will support efforts to:

- identify water quality problems (and sources of problems)
- document existing health of our lakes and streams and track long term changes
- plan appropriate projects to improve water quality
- demonstrate compliance with the county's National Pollutant Discharge Elimination System (NPDES) permit for the stormwater system

2001 was the first year of the Long-term Index Site Project, a Clark County Water Resources effort to gather and analyze data on existing stream conditions, then monitor these streams to track long-term changes in their health. Ten sites are monitored for the following on a regular basis:

- monthly sampling for bacteria, nutrients and minerals; temperature, pH, oxygen, and turbidity (measure of cloudiness of water)
- annual habitat surveys and measurements
- annual sampling of benthic macroinvertebrates that are indicators of water quality
- continuous monitoring of stream temperature
- continuous measurement of stream flow (beginning 2002)

Volunteer-collected data from this project support the monitoring objectives of the Long-Term Index Site Project and the Clean Water Program. Sites for volunteer monitoring are selected to increase the coverage of Water Resources' monitoring network. Several years of sampling and monitoring will be necessary before water quality trends can be detected. At present, the health of each stream varies according to the amount of human disturbance in its watershed, and while some are quite pristine, others are severely degraded.

Water Quality in Clark County

Intensive water quality and habitat studies have been conducted for a few streams and rivers in the larger watersheds of Clark County including Burnt Bridge Creek, Salmon Creek, Lacamas Creek, and the East Fork of the Lewis River (EnviroData Solutions, Inc., 1998; Pacific Groundwater Group, 2002; HDR Engineering, Inc., 2002; Raymond, et.al. 1997; Hutton, 1995). Based on the results of the various monitoring projects, the Washington Department of Ecology has identified many of these waterways and their larger tributaries as 'water quality limited' in terms of attaining designated beneficial uses (Cusimano and Giglio, 1995; Nocon and Erickson, 1996). Common symptoms of poor stream health in Clark County include elevated water temperature, pH, and fecal coliform levels, and diminished dissolved oxygen levels.

The spatial extent of available information is limited in Clark County. Ambient monitoring in smaller sub-watersheds helps to provide information about the degree of water quality limitation and to describe the current condition on which to base management decisions.

Endangered Species in Clark County

"The Columbia River salmon have always been a vital part of our heritage here in Clark County. In fact, they are a defining symbol of the Pacific Northwest. But today the wild fish are nearly gone, victims of pollution, urban growth, dams, logging, over-fishing, and other human activities" (http://www.clark.wa.gov/site/esa4/esahome.htm).

"In the lower Columbia region, steelhead, chum, chinook, and bull trout have been listed as threatened under the federal Endangered Species Act (ESA). The ESA requires Clark County and other jurisdictions to ensure their actions don't jeopardize the continued survival of these fish. Failure to take appropriate actions could result in fines or lawsuits to the county and its citizens. But saving salmon can also be an opportunity to improve the quality of life in our county" (http://www.clark.wa.gov/site/esa4/esahome.htm).

Maintaining a level of water quality that supports the habitat needs of endangered fish is an important component in regional salmon recovery and planning efforts. Quality data and information that can be used to guide agencies' efforts is an important requisite, one that can be partially fulfilled with the help of volunteers.

Public Involvement in the Clean Water Program

A nine member citizen advisory commission, called the Clark County Clean Water Commission (Commission), serves as an advisory body to the Board of Clark County commissioners (BOCC) to provide advice and recommendations regarding Clean Water Program related issues. The Commission has expressed concern in what its members view as 1) gaps in field data; 2) poor coordination among agencies and volunteers; 3) the lack of a centralized data management system; and 4) limited opportunities for volunteers and agency staff to be trained in collecting reliable data (Clark County Clean Water Commission 2001 Annual Report). In 2001, Water Resources took steps to address the Commission's requests for 1) additional public education and outreach; 2) an increase in NPDES water quality-monitoring activity; and 3) seeking grant opportunities for coordination and training of volunteers.

Clark County was awarded a grant by the Washington Department of Ecology in 2002 to establish a shared "monitoring resource center" for the various monitoring and coordination needs of local agencies, students, and adult volunteers. The resource center helps coordinate monitoring activities, provides training to volunteers and local agency staff, maintains an equipment borrowing facility, and establishes indicators, data management, and reporting systems suitable for volunteers.

In addition, Water Resources developed a volunteer monitoring program to provide opportunities for citizens who wish to volunteer their time studying and evaluating the health of regional water resources. Water Resources staff coordinate volunteers' monitoring activities at selected stream and lake sites that meet specific project criteria.

Project Description

Goals and Decision Statement

The data from this project will be used to estimate the current stream-condition of four Clark County streams. Criteria for the determination include 1) comparison of physicochemical data to water quality standards and aquatic life criteria; 2) calculation of water quality and biological integrity indices; and 3) comparison of calculated stream-habitat characteristics to regional reference values, as determined by other agencies and organizations. The data will also serve as the baseline for comparison in future studies.

Objectives

Project objectives include 1) establishing, training, and maintaining teams of volunteers for collecting and reporting useful, credible stream-data to the public, and other agencies and organizations; 2) facilitating public involvement and education in stream monitoring and watershed stewardship; and 3) monitoring and estimating the current condition of four streams in Clark County based on comparison with regulatory standards and aquatic life criteria, and standardized health indicators.

Project Milestones

- Incorporate or develop a set of parameters and indicators suitable for volunteers' use in water quality data gathering and habitat characterization.
- Develop a set of standard protocols for water quality data gathering in streams.
- Identify, procure, and maintain equipment necessary for carrying out protocols for data gathering.
- Develop and implement an equipment lending system at Clark County.
- Develop a data management system capable of reporting in Ecology's Environmental Information Management (EIM) system data standard.
- Develop a data summary, and Draft and Final reports that present, summarize, and evaluate the data based on the project's goal of estimating current stream condition. Volunteer collected data will be used in Water Resources' reports of stream-health in major watersheds.

Organization and Schedule

Project Team

Water Resources' activities are administered through Clark County Public Works as part of the county's NPDES Stormwater Management Program. Earl Rowell is the Water Resources manager. Rod Swanson, Senior Planner, coordinates monitoring activities within the NPDES program and between the program and other agencies, and directs lead/support staff. Ron

Wierenga, Water Resource Scientist, is the project manager, primarily responsible for project design and implementation, volunteer training, QA coordination, and data analysis. Jeff Schnabel, Water Resources Scientist, supports the training of volunteers and field activities.

Gary Bock, Washington State University Cooperative Extension, is the volunteer coordinator and is responsible for recruiting and managing the activities of volunteers, and coordinating training events.

Trained volunteers carry out scheduled field activities, including collecting samples, and recording field measurements and observations. The volunteers document field activities on datasheets and forms, and submit samples to Water Resources for lab analysis.

North Creek Analytical, Inc (NCA) performs laboratory water quality analyses for the project, a Washington Department of Ecology (Ecology) accredited laboratory located in Beaverton, Oregon. Rhithron Associates, Inc., a qualified macroinvertebrate identification laboratory, analyzes benthic macroinvertebrate samples for the project. Laboratory contracts may change as project needs evolve.

Schedule of activities
A task list for project planning, development, and implementation is shown in Table 1. Volunteers four times per year carry out field activities. Samples are submitted by volunteers to Water Resources and a contracted laboratory according to the requirements prescribed by specific characteristic methodologies. This information is detailed in the 'Field and Laboratory Procedures' sections of this document. An annual schedule of volunteer activities is shown in Table 2.

Schedule Limitations
This is a volunteer monitoring program and schedule limitations are to be expected. Factors such as weather and high flows may affect the timing of field activities. Volunteers are instructed to determine specific dates for field activities depending on the team members' schedules. As a result, the timing of field activities may be affected by volunteer availability. Equipment is borrowed from Water Resources to perform field activities and is also subject to availability. Volunteers are encouraged to plan in advance and reserve equipment for the dates that suit their team's needs.

Project Duration
The grant funding for this project ends in December 2004. Volunteers are instructed to monitor their assigned sites from October 2002 to October 2004, at which point Water Resources may assign new sites to obtain information required by the goals of the Clean Water Program. This QAPP, and future revisions, will apply to all stream-monitoring activities carried out by volunteers in the volunteer monitoring program.

Table 1. Tasks for project planning, development, and implementation.

Project Task	Timeline	Location	Staff Resources
Project planning meeting	August 2002	Water Resources	Ron Wierenga, Jeff Schnabel, Rod Swanson
Reconnaissance visits to potential sample sites	August 2002	Field	Ron Wierenga, Jeff Schnabel, Derrick Brooks
Landowner contact for stream access permission	August 2002	Field	Ron Wierenga
Organize volunteers for sampling	September 2002	NA	Gary Bock
Develop stream monitoring manual	September 2002	NA	Ron Wierenga
Develop volunteer training program	September 2002	NA	Ron Wierenga
Purchase monitoring equipment	October 2002	NA	Ron Wierenga
Develop volunteer and equipment tracking database in Microsoft Access	October 2002	NA	Ron Wierenga
Seasonal volunteer orientation and training	October 2002	CASEE and field site	Ron Wierenga, Jeff Schnabel, Gary Bock
Fall season field activities	October 2002-National Water Monitoring Day	Field	Ron Wierenga, Gary Bock
Organize volunteers for sampling	December 2002	NA	Gary Bock
Seasonal volunteer orientation and training	January 2003	CASEE	Ron Wierenga, Jeff Schnabel, Gary Bock
Establish monitoring teams and assign volunteers to sites	January 2003	NA	Ron Wierenga, Gary Bock
Winter Season field activities	February 2003	Field	Ron Wierenga, Gary Bock
Edit stream monitoring manual	February 2003	NA	Volunteers
Distribute program overview and monitoring manual for peer review	March 2003	NA	Ron Wierenga
Finalize program overview and monitoring manual for web publishing	March 2003	NA	Ron Wierenga
Integrate volunteer data into Water Resources’ database	April 2003	NA	Ron Wierenga
Implementation completion review	April 2003	NA	Project Team

Table 2. Annual schedule of volunteer field activities.

Quarterly Monitoring Sessions										
	Benthic Macroinvert-ebrates	Fish & wildlife sight-ings	Noxious weeds	Flow	Photo-point photos	Canopy closure (densio-meter reading)	Canopy type/ Conifer stem count	Physical habitat (cross-section, LWD, substrate, pools, erosion/ revetment, gradient)	Water Quality (temperature, dissolved oxygen, conductivity, pH, turbidity)	Grab samples for fecal coliform, E. Coli), and nutrients
Winter (Jan)		X	update as needed	X	X	X	Conifer stem count (every 5 years)		X	X
Spring (Apr)		X	update as needed	X	X				X	X
Stream-walk (July)		(with Stream-walk)	(with stream-walk)		X					
Summer (Aug)		X	update as needed	X	X	X	Canopy type %'s	X	X	X
Fall (Sept 15-Oct15)	X	X	update as needed	X					X	X

Sampling Design

Volunteer program development

As stated earlier, the data from this project will be used to estimate the current stream-condition in four Clark County streams, as influenced by the cumulative impact of factors in the watersheds studied. Criteria for the determination include 1) comparison of physicochemical data to water quality standards and aquatic life criteria; 2) calculation of water quality and biological integrity indices; and 3) comparison of calculated stream-habitat characteristics to regional reference values, as determined by other agencies and organizations.

An existing volunteer stream-monitoring program was preferred as a model for developing the procedures for this project. Of the many volunteer monitoring programs in existence, the design of the Streamkeepers of Clallam County Project, Natural Resource Division of Clallam County in Washington State most fittingly linked with needs of this project. Clallam County has developed a stream-monitoring manual that incorporates a holistic approach of stream-condition assessment (Streamkeepers of Clallam County, 2002). The design of the monitoring program has been summarized in an Ecology approved Quality Assurance Project Plan (Baccus and Chadd, 2002).

In implementing the program in Clark County an effort to preserve the integrity of the Clallam County Streamkeepers program was made, only changing the parts of the monitoring manual necessary to 1) make it suitable for Clark County's monitoring objectives; and 2) reflect available equipment and staff resources. The changes were minor and the majority of the field procedures are presented literally in the volunteer stream monitoring manual.

This project follows a holistic approach of monitoring streams, considering the chemical aspects of the stream's water quality, as well as the physical and biological character of the stream (Murdoch, Cheo, and O'Laughlin, 1996). Volunteers make field measurements and collect samples for submission to Clark County for analysis. Volunteers are trained by Water Resources in the use of the stream monitoring procedures and equipment.

Sample reach and site selection

Water Resources staff identified a preliminary list of sample reaches in several sub-watersheds with limited or dated stream-health information. From the list, four sample reaches near the outlet of the sub-watersheds were chosen 1) where data would support existing Water Resources or partner projects; 2) that were easily accessible by volunteers; 3) that allowed enough stream distance to perform field procedures (typically 100-200ft); and 4) where stream access was secured from private land owners. Water Resources assigned 'site names' and described the locations. Volunteer sample locations are described in Table 3, and are shown, along with locations of current Water Resources monitoring sites, in Figure 1.

Volunteers identify and establish monuments marking a baseline and permanent cross-section within each sample reach. Water samples are collected from representative locations within the reach and macroinvertebrate samples are collected from four riffles located within or just outside the reach boundaries. Physical habitat measurements are made at several locations along the baseline of the reach.

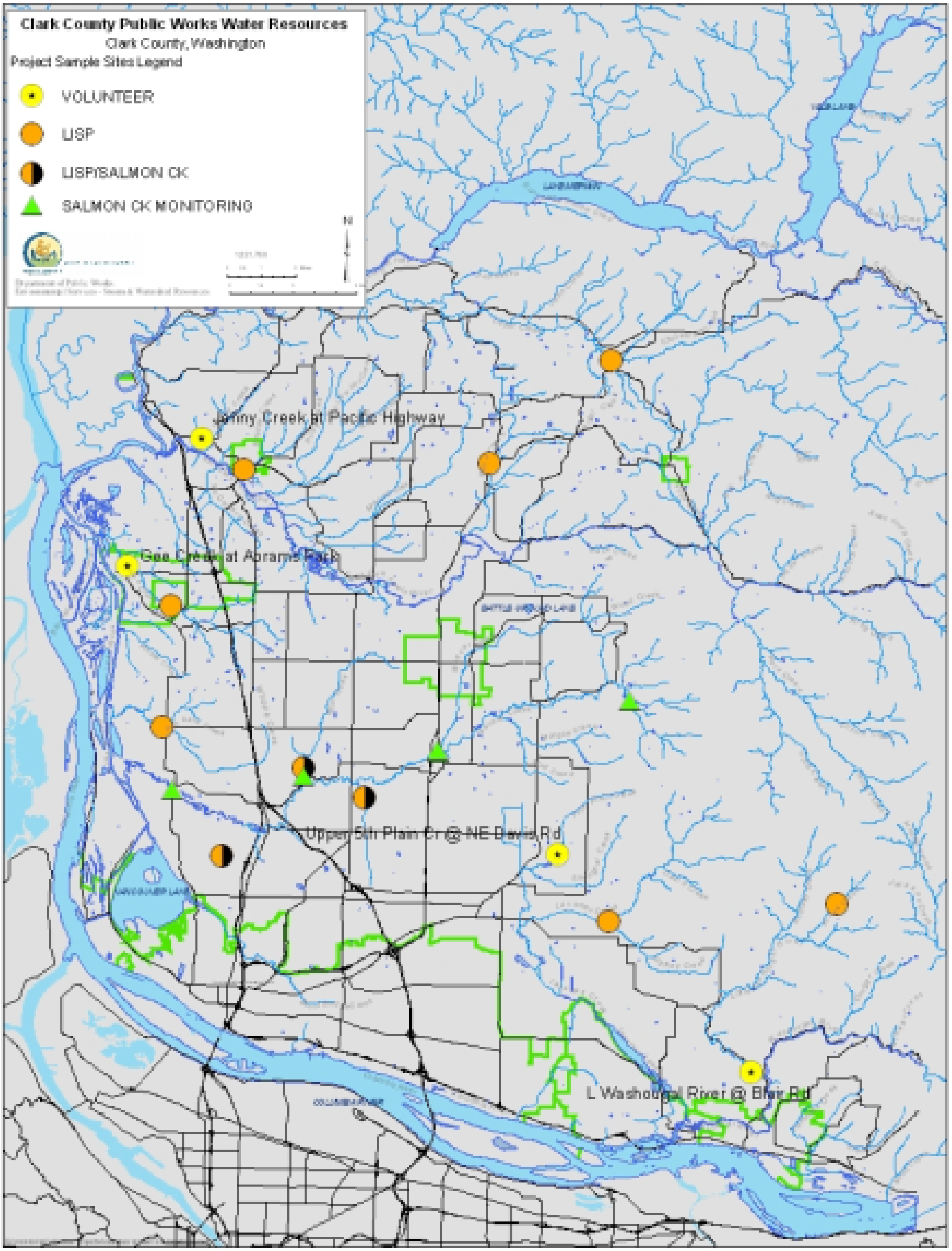

Figure 1. Volunteer and Water Resources monitoring locations in 2002-2003.

Table 3. Volunteer sample station information.

Station Name	Station Type	State Plane South X Value	State Plane South Y Value	Station Location Description
JEN010	Stream/River	10811854.470	204649.940	Jenny Creek at Pacific Highway Crossing
GEE030	Stream/River	1069755.140	184815.970	Gee Creek at Abrams Park
FPL050	Stream/River	1136616.700	140014.040	Fifth Plain Creek at Davis Road Bridge 302
LWG010	Stream/River	1166520.370	106046.370	Little Washougal River at Blair Road Bridge 307

Monitoring characteristics and frequency

Volunteers perform field measurements and collect water samples quarterly over a two year period. Physical habitat measurements are performed in the summer, during low-flow, and macroinvertebrate samples are collected during the late summer to fall period, August to October. Water chemistry and grab samples are collected throughout the year. Chemical, physical, and biological characteristics are shown in Table 4.

Table 4. Chemical, physical, and biological characteristics of the project.

Biological Parameters	Chemical Parameters	Physical Habitat Parameters
Benthic macroinvertebrates Fish and wildlife observations Noxious Weeds observations Fecal coliform samples	Temperature, Water Dissolved Oxygen Conductivity pH Turbidity Total Phosphorus Nitrate+Nitrite-N	Reach Maps Flow/stage Gradient Cross-section Measurements Substrate Pools Large Woody Debris Canopy Closure Canopy Type Conifer Stem Count Erosion Observations Revetment Observations Photographs

Data analysis

The Oregon DEQ Water Quality Index is calculated from the water quality measurement and sample data (Cude, 2001). The index is a single number expressing water quality by integrating measurements of selected characteristics including water temperature, dissolved oxygen, BOD, pH, ammonia+nitrate nitrogen, total phosphourus, total solids and fecal coliform. The index can be used with fewer characteristics, although the results may not be as robust. The index is used to assess the condition of the site as well as in a comparison of reaches within a watershed or between watersheds.

Ten measurements, or metrics, that describe the community of macroinvertebrates are calculated from the raw macroinvertebrate data. The Benthic-invertebrate Index of Biological Integrity (B-IBI) is a regionally developed index, calculated from the set of metric data and used as an overall indicator of stream health (Karr, 1998; Karr and Chu, 1999). The index is used to measure changes in biological communities from activities impacting the stream or watershed, both degrading and rehabilitating actions. Researchers have found the B-IBI to be sensitive to minor impacts from human disturbance within streams in Washington State (Fore, 1999; Merritt et al., 1999).

Metrics calculated from habitat data are compared between sample sites and regional reference data.

Representativeness
The sample sites have been selected to represent conditions at the outlets of small sub-watersheds. The stream-condition assessment is applicable only to the segment of the stream studied, not to the entire waterway within the watershed. The characteristics of the sub-watershed as a whole are expected to shape the condition of the stream at the monitoring locations. Sample sites are located far enough downstream of road crossings, culverts, or major tributaries and piped inflows to avoid direct influence on the characteristics studied.

Quarterly sampling is intended to describe stream conditions during each major season. Volunteers are instructed to avoid sampling after major storms or other events that may disrupt the baseline conditions expected during a particular season. Avoiding storm events will likely miss critical periods for some characteristics, most likely the water chemistry constituents. This may lead to an overestimation of water quality condition in the assessment and it will be important to view the water chemistry data as an *estimate* of condition.

Sampling protocols are designed to facilitate the collection of representative samples. For example, benthic macroinvertebrate collection requires that potential riffle sampling sites are not disrupted during field work and that other measurements, such as habitat or discharge, be made after the macroinvertebrate samples are collected. Macroinvertebrate sampling is also conducted from downstream to upstream in order to avoid contamination of downstream samples. Water samples and measurements are made from well-mixed locations in the channel thalweg, avoiding influence of surface film or the bottom substrate. All instruments are allowed to equilibrate prior to recording data.

Comparability
One of the objectives of this project is to turn out data that are comparable to other local and regional data. In volunteer monitoring, projects must balance 1) monitoring and data requirements on a regional scale; 2) the level of sophistication and effort associated with professionally collected data; and 3) a technique volunteers can utilize with a high likelihood of success. Utilizing comparable protocols and techniques that are less intense than more rigorous investigations, volunteers are capable of successfully collecting a number of types of data. Specifying standard procedures for data collection and analyses facilitates the long-term comparability of volunteer collected data. Furthermore, following examples of established volunteer monitoring procedures, developed in consultation with experts, guards against generating data that will be irrelevant to natural resource managers or the public.

Data collected under this volunteer project will be compared between project sites and between years. Physicochemical data will be examined in light of applicable state standards and criteria for Washington State Class A waterways. Physicochemical data will also be analyzed using a standard water quality index suitable for volunteer collected data, which will allow comparison of project sites to other areas.

Benthic macroinvertebrate samples, collected by the volunteers, are professionally analyzed to facilitate the calculation of standardized community metrics and indices for direct comparison with regionally collected data. The B-IBI has been used to estimate the effects of a wide variety of land uses on streams in the Puget Sound area including urban and suburban development, forestry, and agriculture. Currently, Seattle Metro, Seattle Public Utilities, Cities of Bellevue, Issaquah, and Kent; and Kitsap, Pierce, Snohomish, and Thurston Counties, use a common protocol and the B-IBI for management and permitting purposes (Johnson et al., 2001). Volunteer groups, including Salmonweb and the Clallam County Streamkeepers in Washington State, also collect macroinvertebrate data utilizing the protocol.

Data Quality Objectives

The measurement quality objectives for this project (MQO's) are shown in Table 5. MQOs for the project are set at generally accepted targets for ambient water quality monitoring projects. Assessing data quality for parameters not listed in Table 5, such as for the macroinvertebrate and physical habitat monitoring, is discussed in the 'Quality Control' section of this document. Data quality objectives and quality control procedures for laboratory parameters are detailed in North Creek Analytical's quality assurance documents (North Creek Analytical, Inc., 2001).

Collection, preservation, transportation, and storage of samples follow standard procedures designed to reduce most sources of sampling bias. Analytical bias is minimized by adherence to the methods listed in Table 6. The laboratory employs quality control procedures appropriate to the analytical procedures, including analysis of method blanks, matrix spikes, and check standards.

Table 5. Summary Measurement Quality Objectives (MQO's) of laboratory and field parameters.

Parameter	Accuracy	Precision	Bias	Required Reporting Limit
	% deviation from true value or units of measurement	Relative Standard Deviation	% of true value	Concentration units
Temperature, Water	0.1°C	NA	NA	1°C to 25°C
Dissolved Oxygen	0.3 mg/L 2% saturation	NA	NA	0.1 mg/L to 15 mg/L
Conductivity	3 uS/cm	NA	NA	1 uS/cm
pH	0.2 SU	NA	NA	1-14 SU
Turbidity	25%	10%	5%	1 NTU
Total Phosphorus	25%	10%	5%	0.01 mg/L
Nitrate-Nitrite as N	25%	10%	5%	0.01 mg/L
Fecal Coliform	NA	25% (log transformed)	NA	2 MPN/100mL

Field Procedures

This project uses a field procedure manual put together by Clark County Water Resources (Wierenga, 2002) that was modeled after the procedures of the Streamkeepers of Clallam County. Changes were made in the benthic macroinvertebrate and flow protocols to reflect project goals and available resources. Table 6 details the field procedures and the sampling requirements for each characteristic.

Calibrating field instruments
The Hach 2100P turbidimeter, and the pH and conductivity sensors on a YSI 85 and YSI 60 respectively, are calibrated by Water Resources staff prior to checkout by volunteers. Volunteers on site calibrate the dissolved oxygen sensor on the YSI 85, following procedures detailed in the volunteer monitoring manual. The calibration and maintenance procedures, as described in instrument operation manuals, are followed.

Flow of field activities
Volunteers are trained to follow a general flow of sampling procedures. Monitoring dates are arranged by the team and confirmed with Water Resources staff to ensure equipment availability. Volunteers inspect field kits for completeness given the parameters to be monitored on each trip. Reaches are visited from lowest to highest in the watershed, when applicable, during any given sampling event. At a given reach, volunteers begin with fish and wildlife observations and a general site assessment, including safety procedures. Water samples and measurements are taken after the site assessment is completed. All chemical measurements and macroinvertebrate samples are taken upstream of places volunteers have walked in the stream. Any habitat measurements and photos are taken after the more sensitive work has been completed. Volunteers verify that the tasked work has been completed before leaving the site and returning the equipment to Water Resources staff.

Equipment decontamination and waste disposal
Volunteers use a 1-L LDPE Nalgene bottle to collect grab samples from the stream's main flow. Individual sample bottles for nutrients, turbidity, and bacteria are filled out of the 1-L bottle. If more than one reach is monitored on the trip, Water Resources staff provides multiple clean 1-L bottles. Volunteers use a 500-mL wash bottle filled with DI water to decontaminate field instruments prior to use and storage. There are no procedures used in the field that generate regulated wastes requiring special handling and disposal.

Sample identification and handling
The site name and sample date identify samples collected by volunteers. Water Resources staff fills in 'Client Name', 'Project Name', and 'Sample ID' fields on bottle labels; volunteers fill in the 'Date' and 'Time' fields. Unique sample ID numbers are assigned by contracted laboratories. Sample bottles are stored in large coolers with an appropriate amount of ice packs to keep them cold. Prior to sampling, arrangements are made with contracted labs to pick up samples, allowing sufficient time to analyze them within holding-time requirements. Often samples are collected on by volunteers on Sunday afternoons and picked-up by the lab on Monday mornings.

Data management and field activity logs
Volunteers fill-in the appropriate fields on the data sheets, including the checklists detailing the actions required to verify the data and submit it to Water Resources for review and entry into the database (See Appendix A for data sheet examples). Volunteers are directed to review all of the sheets and then initial appropriate fields indicating that the forms are complete. A sample tracking sheet is filled-in by volunteers indicating the samples that were collected, sample times, and personnel. Water Resources staff completes the chain of custody forms that are submitted to the lab using this information. Water Resources staff confirms that the data was received and reviewed for completeness, then enters available data into the Water Resources database. All field data sheets and sample tracking forms are bound and stored at the Water Resources office as a log of field activities.

Table 6. Field procedures and sampling requirements of the Volunteer Stream Project.

Field Activity Type	Sampling Frequency	Method	Equipment	Sample Size	Container/ preservation	Holding Time
Benthic macro-invertebrate sample	Annually in late-summer	Ecology collection method; BIBI metrics.	D-Frame net, 500-µm mesh and sieve size	4-riffle comp.	1-L LDPE bottle/90% ethanlol	NA
Flow/stage measurement	Quarterly	Mid-section incremental flow method	Marsh-McBirney model 201D current meter	15-20 points across stream	NA	NA
Gradient measurement	Annually	Slope method	Sight Mark II level and rod	NA	NA	NA
Cross-section survey	Annually	Monuments	Tapes and levels	variable	NA	NA
Erosion/ revetment observations	Annually	Observation	Tapes	Survey	NA	NA
Substrate measurement	Annually	Pebble count	Ruler	100 pebbles	NA	NA
Pools measurement	Annually	Survey	Leveling rod; tapes	Survey	NA	NA
Large woody debris (LWD)	Annually	Survey	Tapes and ruler	Survey	NA	NA
Canopy closure measurement	Semi-Annually	Densiometer	Spherical densiometer	4 measures	NA	NA
Water temperature measurement	Quarterly	EPA 170.1 Thermistor	YSI 85 multimeter	NA	NA	In-situ
Air temperature measurement	Quarterly	EPA 170.1 Thermometer	Envirosafe liquid thermometer	NA	NA	On site
Dissolved oxygen measurement	Quarterly	EPA 360.1 Membrane Electrode	YSI 85 multimeter	NA	NA	In-situ
Specific conductance measurement	Quarterly	EPA 120.1 Conductivity meter	YSI 85 multimeter	NA	NA	24 hours
pH measurement	Quarterly	EPA 150.1 Electrometric	YSI 85 multimeter	NA	NA	In-situ
Turbidity measurement	Quarterly	EPA 180.1 Nephelometric	Hach 2100P	10-mL	1-L LDPE/none	48 hours
Nitrogen samples	Quarterly	Grab sample	NA	500-mL	500-mL HDPE/sulfuric acid	28 days
Phosphorus samples	Quarterly	Grab sample	NA	500-mL	500-mL HDPE/sulfuric acid	28 days
Fecal coliform samples	Quarterly	Grab sample	NA	100-mL	125-mL sterile HDPE/ sodium thiosulfate	30 hours

Laboratory Procedures

Clark County Water Resources currently maintains contracts with North Creek Analytical, Inc. and Rhithron Associates, Inc. for all analytical work. Lab contact information is provided below:

Howard Holmes, Project Manager
North Creek Analytical, Inc.
9405 SW Nimbus Avenue
Beaverton, Oregon 97008-7132
503-906-9200
www.ncalabs.com

Wease Bollman
Rhithron Associates, Inc.
1845 South 12th West
Missoula, Montana 59801
(406)721-1977
www.rhithron.com

NCA maintains laboratory accreditation with Washington Department of Ecology. Analytical procedures and quality assurance measures are detailed in NCA's Quality Assurance Plan (North Creek Analytical, Inc., 2001).

Water samples are transported to NCA by laboratory personnel, or properly preserved, packed and shipped to the laboratory for analysis within 24 hours after collection. Standard chain of custody procedures are followed. Analytical results are provided within three weeks of receipt of the samples. Data is reported as digital Excel worksheet files and backed up with mailed hard copies.

Benthic macroinvertebrate samples are preserved immediately after collection and shipped to Rhithron Associates, Inc. at the conclusion of the field season. Laboratory analyses are performed in accordance with Ecology-approved methods for standard taxonomic identifications and metrics (Plotnikoff and Wiseman, 2001). Macroinvertebrates are enumerated and identified to the lowest practicable level, typically to the genus species level.

Table 7. Analytical procedures for water samples collected in project.

Characteristic	Sample Matrix	Number of Samples	Analytical Method	Expected Range of Results
Fecal Coliform	Surface Water	35 total for two seasons	SM 9221E. multiple tube fermentation	< 1-1000 MPN/100mL
Nitrate+Nitrite-N	Surface Water	35 total for two seasons	EPA 353.2 cadmium reduction - colorimetric	< 0.01-3.0 mg/L
Total Phosphorus	Surface Water	35 total for two seasons	EPA 365.1 ascorbic acid - colorimetric	< 0.01-0.100 mg/L

Quality Control

Laboratory QC

Laboratory check standards, matrix spikes, analytical duplicates, and blanks are analyzed in accordance with the NCA Quality Assurance Program (North Creek Analytical, Inc., 2001). All QC results are reported to Water Resources staff along with sample data. Laboratory data reduction, review, and reporting are performed according to the NCA Quality Assurance Program. Data are assessed and reported according to the methods described in the NCA Quality Assurance Program.

Rhithron Associates, Inc. performs QC for laboratory analysis of benthic macroinvertebrate samples, including sorting efficiency and identification verification, according to their quality assurance guidelines.

Field QC
Field QC sample types, frequencies, and definitions for water quality samples are found in Table 8. Laboratory water quality samples and field meter measurements are duplicated annually at each sample site assigned to a team of volunteers. Transfer blanks are collected annually under the guidance of Water Resources staff. There are no field QC requirements for the habitat protocols.

All meters are calibrated and maintained by Water Resources staff in accordance with the manufacturer's instructions. Check standards for conductivity and turbidity are used to verify the accuracy of field meters. An NIST-certified thermometer is used to verify the accuracy of temperature sensors. Calibration logs are completed during each calibration and are archived in Water Resources files. Calibration drift in pH meters is checked against pH buffer solutions and dissolved oxygen measurements are verified using a modified Winkler titration in the field. These activities are used to confirm that field instruments are attaining stated accuracy and resolution specifications.

Table 8. QC sample types, frequencies, and definitions required for the project.

Field QC sample type	Frequency	Definition
Field measurement replicate	Annually per site	repeat field meter measurements
Sample duplicate	Annually per site	duplicate sample collected for laboratory analysis
Transfer blank	Annually per site	D.I. water sample collected in field with sampling equipment

Corrective Actions
Data quality problems encountered in the analysis of QC samples are addressed as needed through re-calibration, modifications to the field procedures, increased volunteer training, or by qualifying results appropriately. Documentation of corrective action steps includes problem identification, investigation procedures, corrective action taken, and effectiveness of the corrective action.

Data Management Procedures

Volunteers record field data on standardized data sheets. The 'master data sheet' is used to record the physicochemical, macroinvertebrate, and physical habitat data. The 'sample tracking' and 'photos' data sheets detail activities producing samples for analysis or photos for archiving. A 'noxious weeds identification' data sheet lists observations made on site by volunteers. Field data may also include 'reach maps' created by volunteers that document the layout of sample sites and changes occurring over time in the stream.

Volunteers review field data sheets for errors and then submit a completed package to Water Resources staff for entry into a database and archiving in bound notebooks. Ultimately the data sheets are digitally imaged and stored electronically on the county's digital imaging system.

Contracted laboratories submit data electronically in Excel spreadsheets and in paper reports. Hard copies of laboratory reports are stored in a project binder. Digital files are backed up on CD on an annual basis, and laboratory data packets are also archived on the county's digital imaging system.

After review, data is entered or imported into Water Resources' water quality database, developed by Water Resources staff. The database is in a SQL Server format, utilizing Access for data entry, editing, analysis, and reporting. A routine is built into the utilities of the database for reporting following the data standard and submittal requirements of Ecology's Environmental Information Management system.

Audits and Reports

Audits

The project manager and QC coordinator periodically review the field data, methods, lab results, and data management activities to make an assessment of the program and identify corrective actions or method revisions.

Reports

A data summary detailing field activity and preliminary data will be completed and submitted annually. Data summaries compiled by Water Resources address project methods, present data, summarize data accuracy and completeness, describe any significant data quality problems, and suggest modifications for future monitoring. Reports are peer reviewed by Water Resources staff. The summary will be made available to volunteers via e-mail list service or in hard copy.

Draft and final reports that present, summarize, and evaluate the data based on the project's goal of estimating current stream condition will be completed within six months of completing the field activities. Volunteer collected data may also be used in the Water Resources' reports of stream-health in major watersheds. Executive summaries, and full reports as warranted, are placed on Water Resources' website to facilitate dissemination of information to the public.

Data Review, Verification, and Validation

During each sample trip, volunteers review field data sheets to confirm that all necessary field measurements and samples have been collected. Laboratory QC results are reviewed and verified by NCA staff and documented in data reports to Water Resources. Upon receipt, laboratory data are reviewed for errors, omissions, and data qualifiers prior to data entry.

Data verification involves examination of QC results analyzed during the project to provide an indication of whether the precision and bias MQOs have been met. To evaluate whether precision targets have been met, pairs of duplicate sample results are pooled and an estimate of standard deviation is calculated. This estimate divided by the mean concentration of the duplicate results and converted to percent can be used to judge whether the %RSD target has been met.

To evaluate whether bias targets have been met, the mean percent recovery of the check standards should be within +/- %bias target of the true value (e.g. true value +/- 10%). Unusually high blank results indicate bias due to contamination that may affect low-level results. To evaluate whether the target for reporting limit has been met, results will be examined to determine if any of the values exceed the required reporting limits.

Data validation consists of a detailed examination of the complete data package using professional judgement to assess whether the procedures in the volunteer methods manual and QAPP have been followed. Data validation is performed by the project manager and QC coordinator during the preparation of annual reports.

Data Quality Assessment

Taking into account the results of data review, verification, and validation, an assessment will be made as to whether the data are of sufficient quality to attain project objectives.

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Appendix A: Field data sheets.

Appendix B: Introduction, program overview, and field procedures table of contents for the Clark County Volunteer Stream Monitoring Manual.